

What's next?

Rhythm-based anticipation in children with ASD

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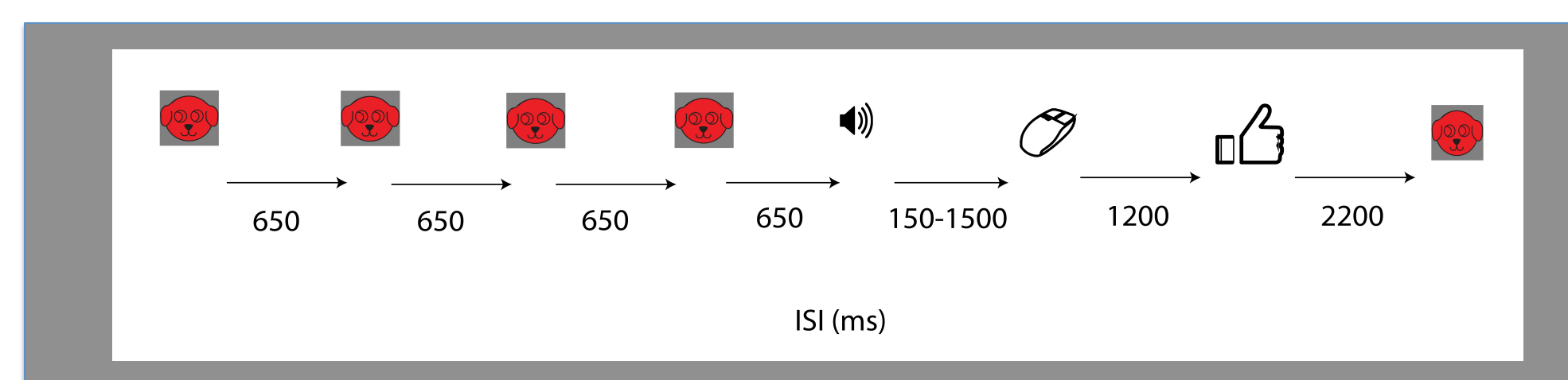
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Background

- Information in the sensory environment tends to be highly predictive of upcoming events.
- Clinical observations and behavioral tasks on individuals with ASD point to deficits in applying predictive information to generate expectations (Chambon et al., 2017; Pellicano & Burr, 2012).
- Using EEG, this study aims to find neural activity underlying altered anticipation in ASD, through examining the role that impaired neural entrainment stimuli might play in processing rhythmic sensory information.
- Children with ASD and Typically Developing (TD) controls responded to the appearance of an auditory stimulus that was either preceded by predictive rhythmic visual stimuli, or not.
- Results show that in contrast to TD, who present entrained activity in channels over temporal scalp areas at the rhythm of stimuli (1.5Hz), children with ASD present reduced entrained activity, reduced phase locking and reduced change in Contingent Negative Variation (CNV).
- We offer a support, based on cortical activity, for impaired event anticipation in children with ASD.

Subjects and paradigm

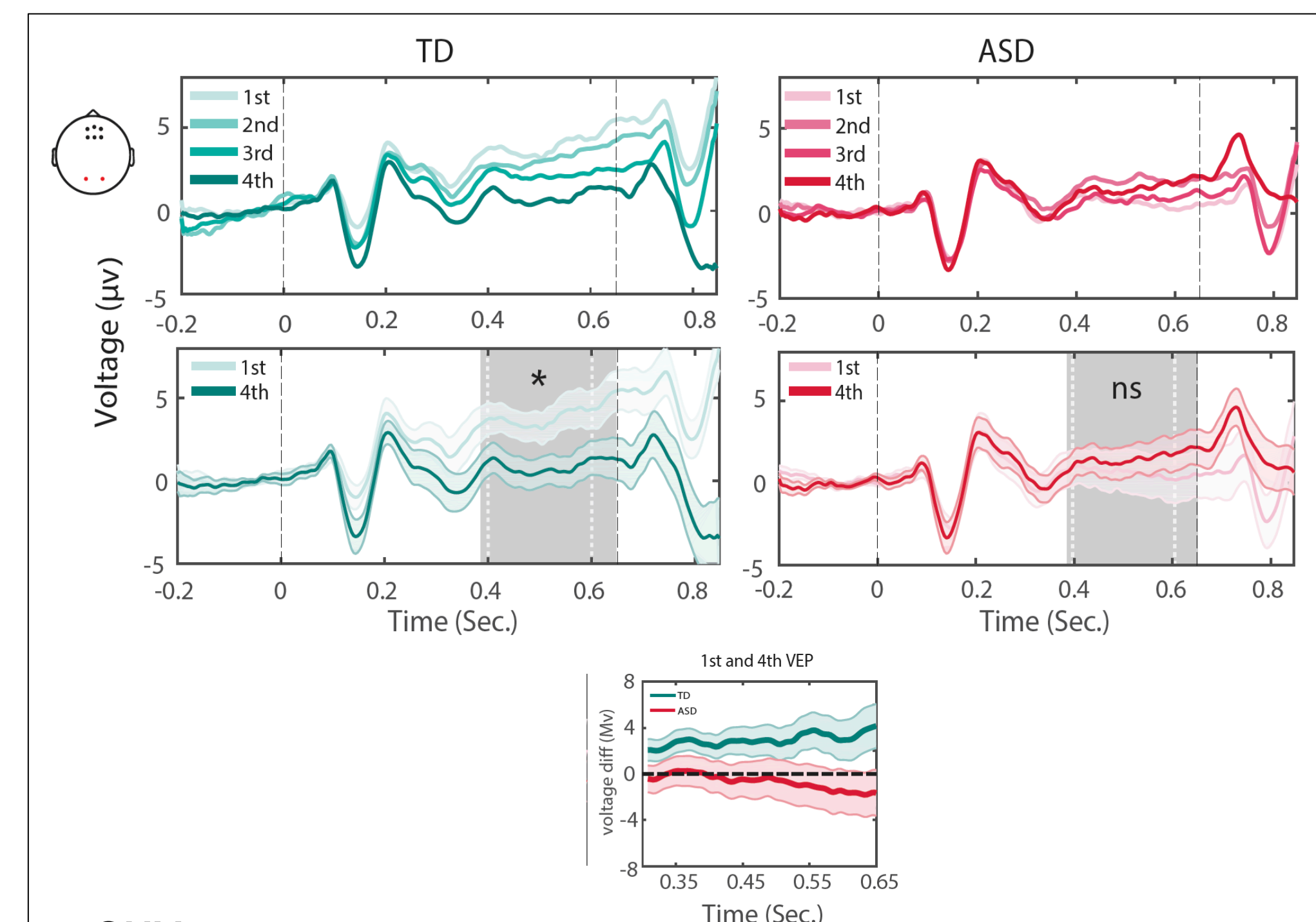
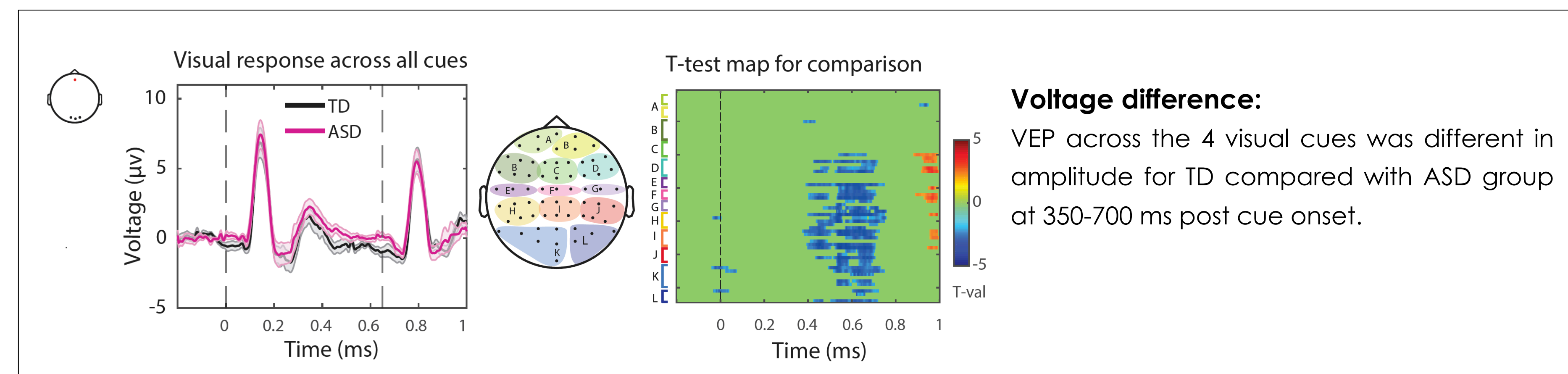
- 31 participants with Autism Spectrum Disorder (ASD; Age: 7.6±1, 25 males), and 20 Typically Developed (TD; Age: 8.3±1.8, 8 males) were analyzed in this study.
- Diagnoses of ASD were obtained by a trained clinical psychologist using the Autism Diagnostic Interview-R (ADI-R; Lord et al., 1994) and the Autism Diagnostic Observation Schedule (ADOS-G; Lord et al., 2000).
- Paradigm: Participants were presented with 4 visual stimuli (duration: 80ms; SOA=650ms), followed by an auditory stimulus (Cue condition). On half of the blocks, the auditory stimulus was not preceded by visual cues (No Cue condition). In all trials, subjects were instructed to press a button upon hearing the auditory tone. A feedback (visual + auditory) was provided for all trials, indicating if correct (between 150-1500ms), too fast, or too slow.



EEG recordings

EEG recordings from 64-channels were collected at digitization rate of 512Hz from all participants. Data was down sampled to 256Hz, band-filtered (between 0.1Hz and 40Hz). Data was epoched differently for each analysis: For time domain analysis: 0.2 before and 0.85 sec. after cue onset. For phase/frequency domain analysis: 3.0 sec. before and 0.5 sec. after target onset.

EEG Results: Time-domain

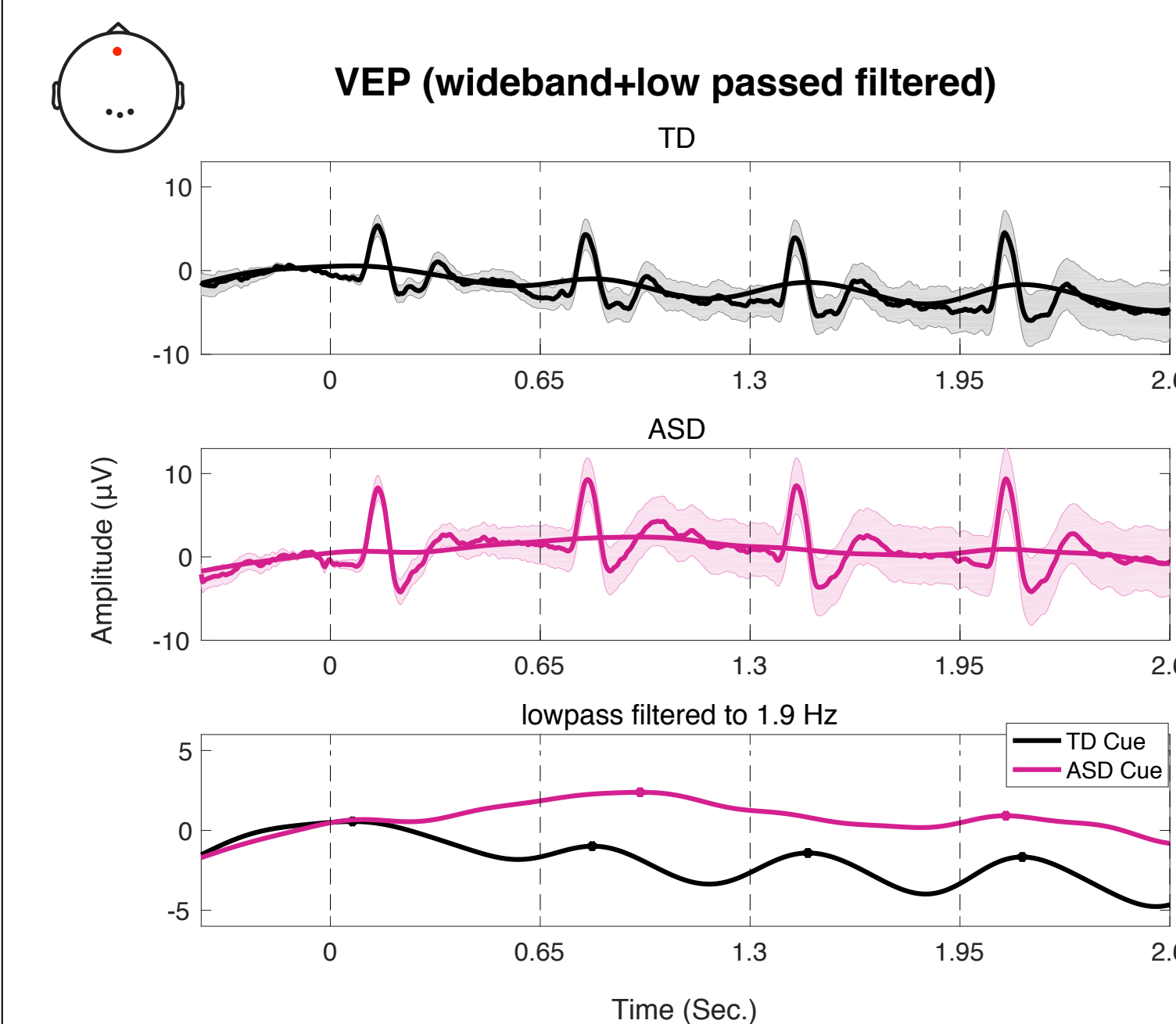


CNV:

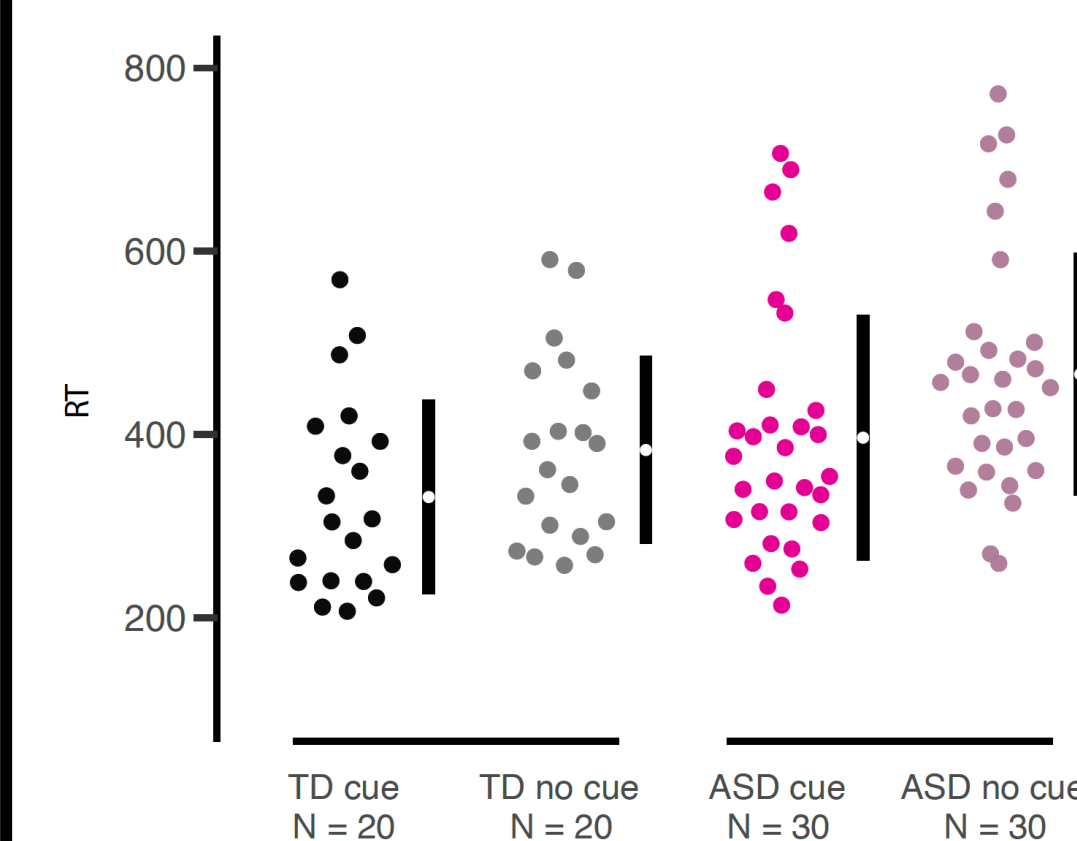
- Contingent Negative Variation (CNV) – a slow change in scalp voltage prior to an impending stimulus.
- Rhythm-based predictions are associated with CNV prior to expected events.
- The anticipatory response in the TD group increased from the first to the last of the 4 visual cues that precede the auditory target. This modulation is diminished in the ASD group.

Rhythmic Entrainment:

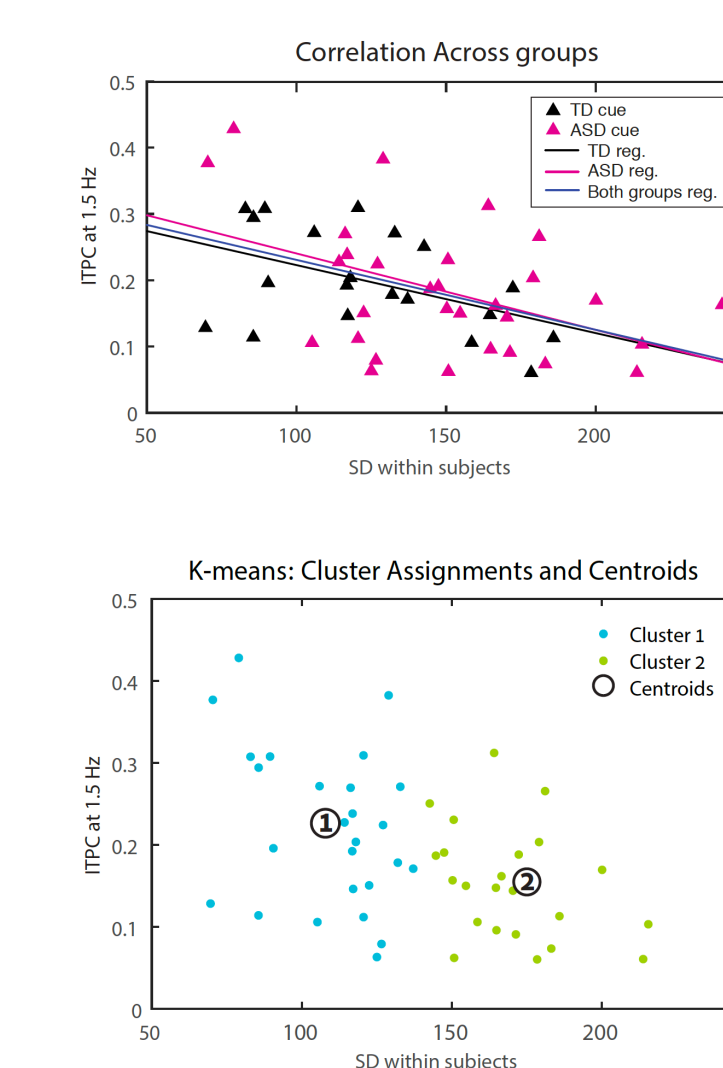
When low-passed to 1.9 Hz, visual evoked responses for the 4 consecutive stimuli show a high phase entrainment to time onset of visual cues.



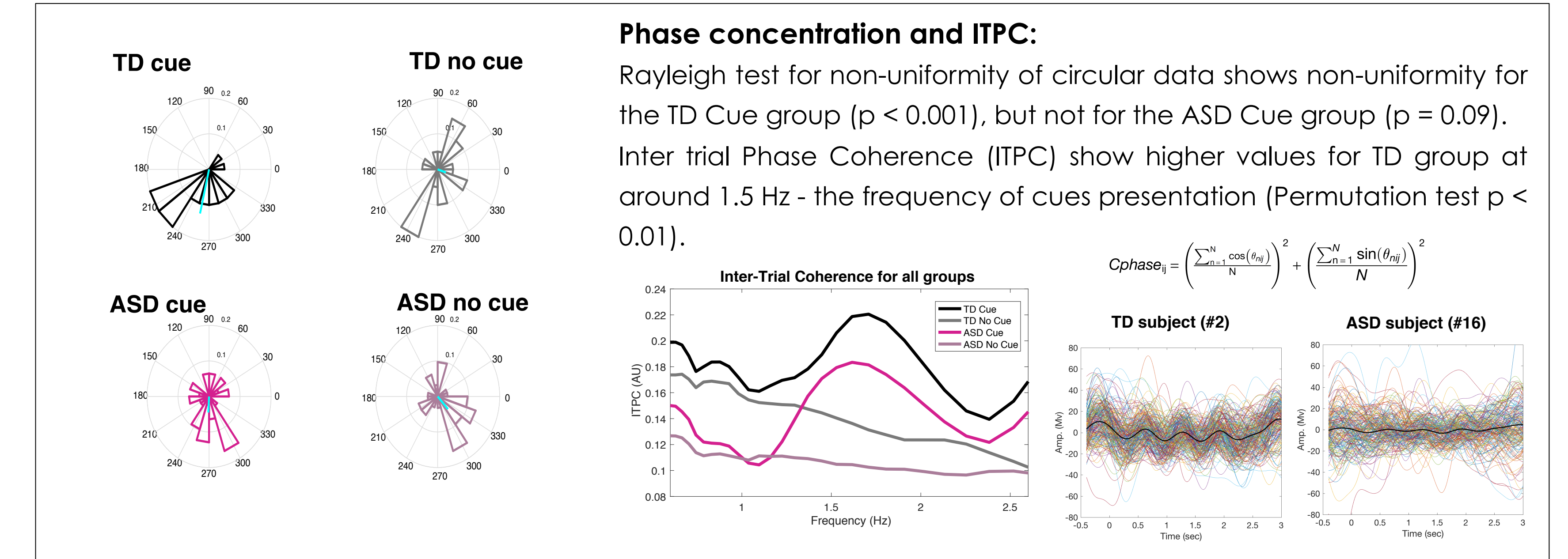
Behavior



- Reaction times (RT) were calculated per participant in each condition. ASD participants showed overall longer RT than control groups (ASD: 430ms; TD: 356 ms). 1-way ANOVA shows main effects in RT for Group ($F=523$, $p < 0.001$) and Cue ($F=105$, $p < 0.001$), but no Group*Condition interaction ($F=0.2$, $p=0.6$).
- No correlation was found for behavior with CNV, frequency power of phase measurements.
- Standard Deviation of reaction time was correlated with ITPC for both groups. (Pearson $\rho = -0.47$, $p < 0.01$).
- ASD were mostly represented by high SD-RT and low ITPC.

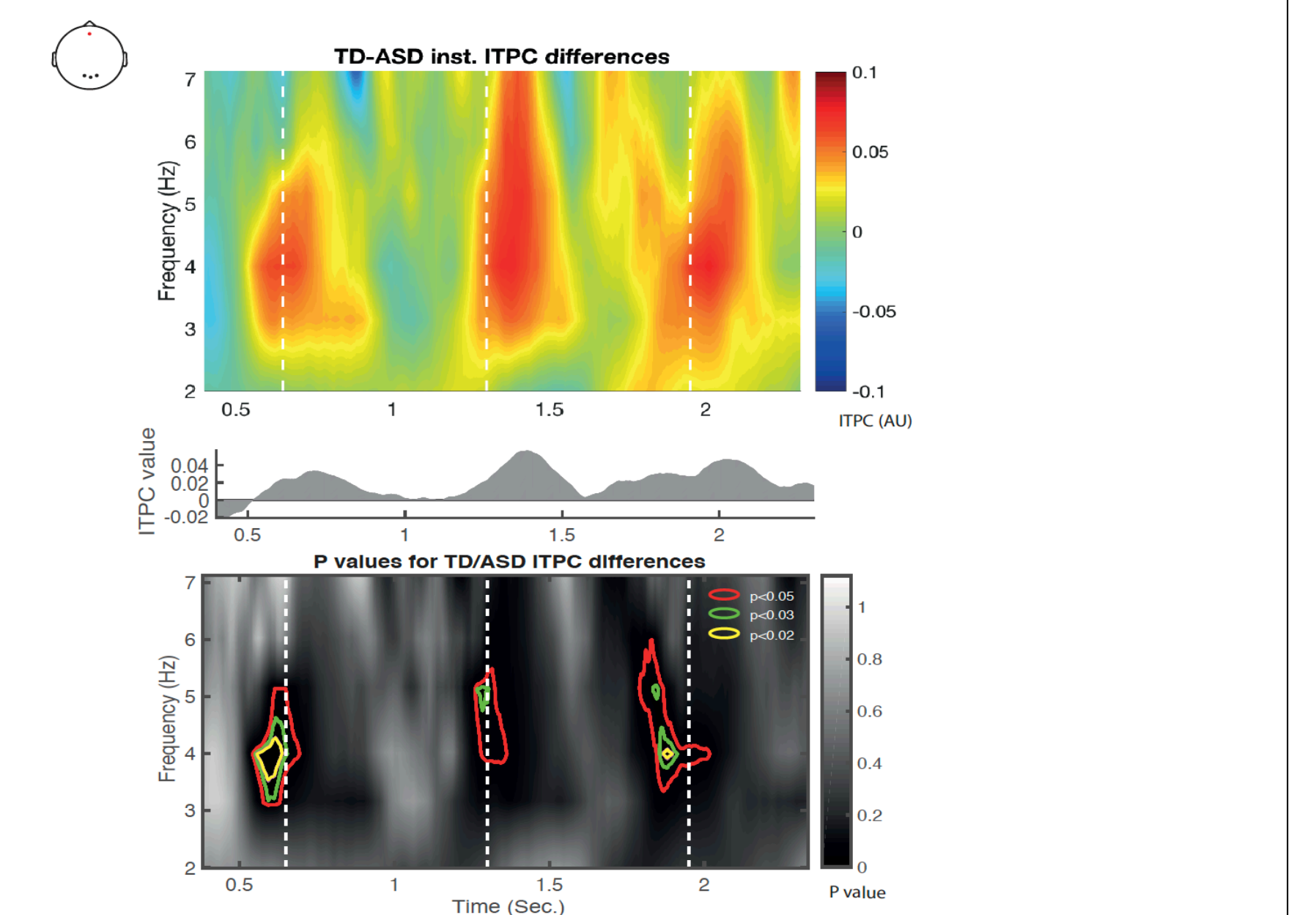


EEG Results: Phase/Frequency-domain



ITPC values for time and frequency

- Inter Trial Phase Coherence (ITPC) was calculated for each time and frequency value, and averaged across subjects in a group.
- Overall, TD group show higher ITPC values.
- ITPC values prior to stimuli onset (marked by white arrows), are lower or ASD group.



Summary and Conclusions

- EEG from groups of children with ASD and Typically Developing (TD) were compared while performing a task where an auditory stimulus was either preceded by rhythmic visual stimuli, or not.
- A graded CNV prior to visual stimulus onset is seen for TD subjects. This pattern is diminished in the ASD group.
- While both groups showed a comparable visual evoked potential after stimulus onset, a modulation at the stimuli rhythm (1.5Hz) that is seen for the TD group was reduced for the ASD group. This is supported by inter-trial phase coherence and by phase concentration at 1.5Hz.
- The above results support the theory for altered expectation in autism and hypo-priors, stating that perception of external events in autism is not inferred by their prior statistics, but instead, by the current event per se (Chambon et al., 2017; Pellicano & Burr, 2012). Altered expectation lead also to a lack of adaptation and lack of surprise when expectations are violated (Lawson, Aylward, White, & Rees, 2015), in accordance with the clinical observations in children with autism.

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